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Changes After Partial Cutting Of A Spruce-Fir Stand In Maine

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IN 1945 A PARTIAL-CUTTING experiment in spruce-fir silviculture was begun by the Penobscot Research Center of the Northeastern Forest Experiment Station. The Eastern Pulp Wood Company of Calais, Maine, made available for the study a tract of forest land in Dyer Township, Washington County, Maine. This 20.6-acre tract is part of a large area that had been burned over in 1885.

The experimental area was set aside for the purpose of conducting a cutting experiment designed to test the following assumptions:

- That vulnerability of a spruce-fir stand to the spruce budworm depends largely on the size and amount of balsam fir present, and on the vigor of the balsam fir and spruce.

- That possible losses from the currently impending spruce budworm attack could be reduced by cutting the most

vulnerable trees: the mature balsam fir and the poor-vigor balsam fir and spruce.

- That stands resistant to damage from a spruce budworm attack could be built up over a long period by cutting methods that reduce the proportion of balsam fir and increase the stand vigor.

- That these cutting practices are good silviculture regardless of spruce budworm attack. They call for a short cutting cycle and improvement in stand structure. The increased quality and rate of growth of the growing stock will result in higher net yields than would heavy cuttings on long cutting cycles.

Since the spruce budworm has not yet reached the experimental cutting area, the first two assumptions cannot be tested. However, a re-measurement of the area in the fall of 1953 does provide information on growth, mortality, and changes in composition that have taken place since the cutting.

THE STUDY

The purpose of the study was to test the effectiveness of cutting methods used to accomplish certain specific objectives. These were:

- To reduce the vulnerability of the softwood growing stock to damage by the spruce budworm by removing the large mature balsam fir trees.

- To increase stand productivity by removing defective and poor-vigor trees--especially balsam fir, which is susceptible to rot at an early age.

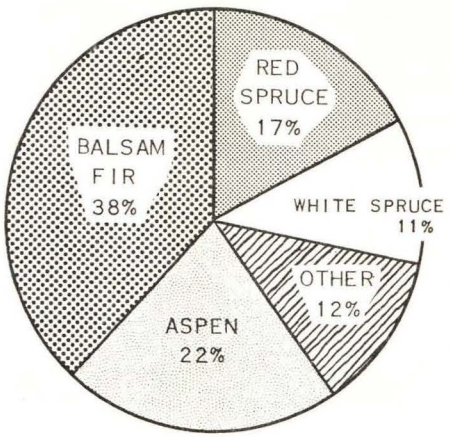
- To retain enough growing stock to allow another operable cut of about the same volume in 20 years.

Trees to be cut were marked. The marking rules were based on tree size, condition, and spacing. Diameter guides were set up as follows:

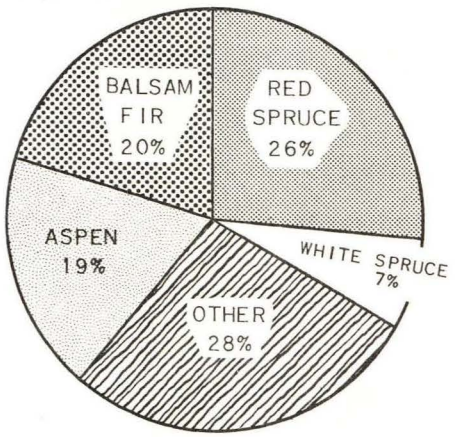
	Inches
Spruce	9.5
Balsam fir	7.5
Aspen	6.5

Defective and poor-vigor balsam fir and spruce trees below these diameter limits were marked to be cut so that the

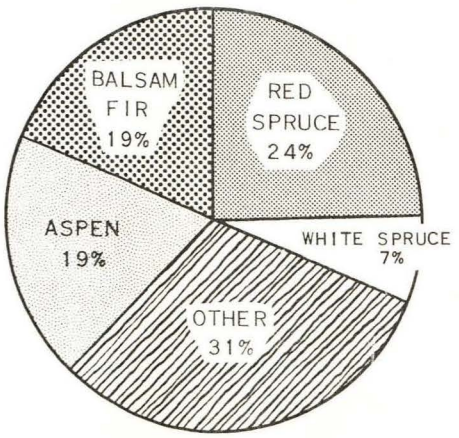
BEFORE CUTTING



AFTER CUTTING
(1947)



IN 1953



vigor of the residual stand would be increased. Some thrifty balsam fir and spruce trees above the diameter limits were retained where needed for proper spacing. Because of rigorous specifications for aspen, some partially defective trees of this species were not cut. Other species were not merchantable for this cut. These rules resulted in a per-acre cut of 10.0 cords of spruce and fir, and 3.8 cords of aspen.

In March 1945, before cutting, a 100-percent inventory was made of the merchantable species 5.6 inches d.b.h. and larger: red and white spruce, balsam fir, and aspen. A 20-percent sample was taken of other species. The stand composition in percent of total basal area was: red and white spruce 28 percent, balsam fir 38 percent, aspen 22 percent, and other species 12 percent (fig. 1). Total volume was 1,854 cubic feet or about 21 cords of rough pulpwood per acre.

An inventory of this tract in April 1947,

FIGURE 1.--Composition of the stand before cutting, after cutting, and 7 years later. The figures indicate percent of total basal area in trees 5.6 inches d.b.h. and larger.

after cutting, showed a total pulpwood growing stock of 615 cubic feet or 7.2 cords per acre. This consisted of 283 cubic feet (3.1 cords) of red and white spruce, 150 cubic feet (1.7 cords) of balsam fir, and 182 cubic feet (2.4 cords) of aspen (fig. 2). These species comprised 72 percent of the total basal area of all trees 5.6 inches d.b.h. and larger. Red maple and northern whitecedar made up most of the remaining 28 percent.

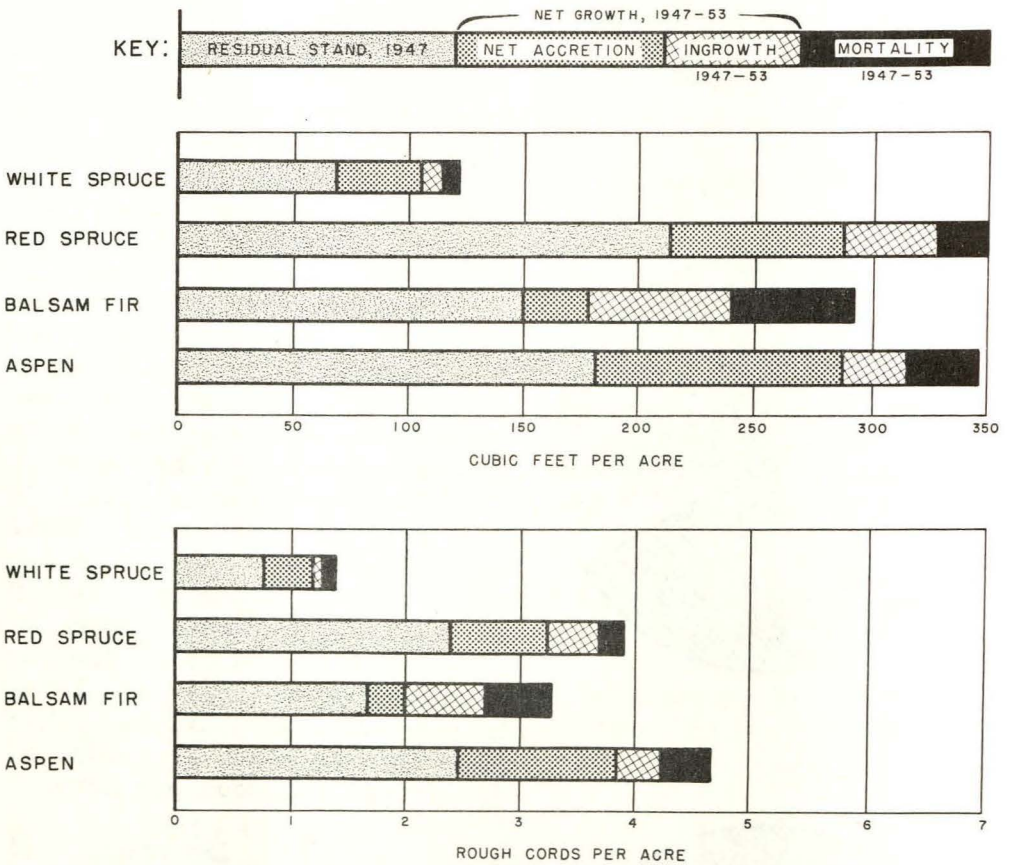


FIGURE 2.--Development of the residual stand between April 1947 and October 1953.

Seven growing seasons later, in October 1953, another inventory was made. At that time the pulpwood growing stock was 1,001 cubic feet or 11.8 cords per acre. It consisted of 445 cubic feet (4.9 cords) of red and white spruce, 240 cubic feet (2.7 cords) of balsam fir, and 316 cubic feet (4.2 cords) of aspen.

THE RESULTS

What evidence is there that the cutting methods used have had a beneficial influence on the development of the stand during these first 7 years?

Budworm Vulnerability

The relative vulnerability of the stand to damage by the spruce budworm before and after cutting and in 1953 was computed, using Westveld's rating table for balsam fir by diameter.[1] The number of balsam fir trees per acre in each diameter class was multiplied by its vulnerability rating. These products were added to compute the vulnerability of the stand. The 1945 cutting reduced the relative vulnerability from 564 (high) to 63 (light). In 1953, due to the increase in size of the balsam fir trees, the vulnerability was 117 (medium).

Composition

The percentage of fir in the stand was reduced by the 1945 cutting from 38 to 20, while spruce was increased from 28 to 33 percent (fig. 1). The proportion of aspen was reduced from 22 to 19 percent. By 1953 the balsam fir component in the growing stock was only 19 percent. Spruce dropped to 31 percent, while aspen remained the same at 19 percent.

The problem of improving composition now lies with the other species that were nonmerchantable in 1945. There has been an increase in the proportion of nonmerchantable species from 12 percent before cutting, to 28 percent after cutting, to 31 percent in 1953. The proportion of merchantable species has dropped from 88 percent before cutting to 72 percent after cutting, to 69 percent in 1953. Removal of the aspen and larger spruce and fir left openings that are being taken over by other species, mostly red maple. In some of the softwood stands cedar is filling in the openings. This species more than doubled in basal area during the 7-year period.

Rate Of Growth

The net periodic annual growth was 16.5 cubic feet

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[1] Westveld, M. A suggested method for rating the vulnerability of spruce-fir stands to budworm attack. Northeast. Forest Expt. Sta. 4 pp. (processed). 1945.

(0.183 cord) for red spruce, 6.7 cubic feet (0.074 cord) for white spruce, 12.8 cubic feet (0.143 cord) for balsam fir, and 19.1 cubic feet (0.255 cord) for aspen--a total of 55.1 cubic feet or 0.655 cord per acre (table 1).

Table 1.--Merchantable stand in 1947 and 1953, with periodic annual growth and mortality

(From 1-foot stump to 4-inch top.)

Species	Units per acre in--		Units per acre per year[1]			
	April 1947	October 1953	Accretion	Mortality	Ingrowth	Net growth
			Cubic feet			
White spruce	69.1	115.9	6.01	0.85	1.53	6.69
Red spruce	213.9	329.2	13.44	2.84	5.87	16.47
Total spruce	283.0	445.1	19.45	3.69	7.40	23.16
Balsam fir	150.4	240.2	11.13	7.27	8.97	12.83
Aspen	182.2	316.0	19.56	4.48	4.03	19.11
All species	615.6	1001.3	50.14	15.44	20.40	55.10
			Rough cords			
White spruce	0.768	1.288	0.067	0.009	0.017	0.074
Red spruce	2.376	3.657	.149	.032	.065	.183
Total spruce	3.144	4.945	.216	.041	.082	.257
Balsam fir	1.671	2.668	.124	.081	.100	.143
Aspen	2.430	4.213	.261	.060	.054	.255
All species	7.245	11.826	.601	.182	.236	.655

[1]Accretion = growth on all trees that were measured in 1947 and remeasured in 1953. For definition of other terms see "Forest Terminology" published by Society of American Foresters, 1950.

The rate of ingrowth is an indication of the vigorous development of the younger elements of the stand. Ingrowth accounted for 37 percent of the net growth. It was 20.4 cubic feet or 0.236 cord per acre per year. Balsam fir ingrowth was the greatest. It was 70 percent of the net fir growth. Red spruce ingrowth was 36 percent, white spruce 23 percent, and aspen 21 percent.

Expressed as a percentage of the 1947 growing stock, the periodic annual accretion rate has been:

	Percent
Aspen	10.7
White spruce	8.7
Balsam fir	7.4
Red spruce	6.3

Mortality

Death of merchantable species from all causes over the past 7 years has been 108.0 cubic feet (1.27 cords) per

acre, a yearly loss of 15.4 cubic feet or 0.18 cord. Balsam fir made up 45 percent of this loss. Although the merchantable volume of fir in 1947 was only about half that of spruce, balsam fir mortality was twice as great (fig. 2). Similarly, fir losses were 35 percent higher than aspen, even though the aspen volume was somewhat greater than fir to begin with.

These figures point up sharply some of the characteristics of balsam fir. The gross volume of fir nearly doubled in the 7-year period. However, fir mortality of 50.9 cubic feet (0.57 cord) per acre reduced the net growth to 60 percent. This was only 3 percent higher than the net increase for spruce. Fir grows fast, but unless it is managed under short cutting cycles (to salvage mortality) most of the advantage of fast growth is lost.

Animals killed 38 percent of the trees found dead in 1953. Two-thirds of the aspen loss was from beaver feeding. About 13 percent of the spruce and balsam fir mortality was due to flooding from beaver ponds. Porcupines were responsible for an estimated 30 percent of the red spruce losses. The following shows the volume and percentage of loss by cause for the 7-year period.

Cause	Loss per acre	
	(cubic feet)	(percent)
Beaver feeding	21.01	20
Beaver flooding	15.30	14
Porcupine feeding	5.40	4
Other	66.37	62
	108.08	100

Other causes of mortality listed above include trees that died as a result of competition and weather factors.

CONCLUSIONS

The 1945-46 cutting, which removed two-thirds of the original merchantable pulpwood volume, accomplished the objectives set up in 1945. It reduced the probable vulnerability of the stand to damage by spruce budworm attack and increased effective stand productivity by eliminating large fir and poor-vigor fir and spruce trees. It retained a growing stock that should support another operable cut when the 20-year cutting cycle is completed.

However, since nonmerchantable species were not removed, repeated cuttings of this sort will result in in-

creasing proportions of these components in the stand, with equivalent decreases in the proportions of merchantable species. Yields of merchantable species will therefore progressively decline. The remedy for this undesirable trend, though not dealt with in the experiment, obviously lies in finding some practical means for disposing of the nonmerchantable species.

A 20-year cutting cycle may be too long for a stand that has a high percentage of balsam fir. Heavy mortality of fir (as compared to that of spruce) points to the need for short cutting cycles to salvage dead trees.

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